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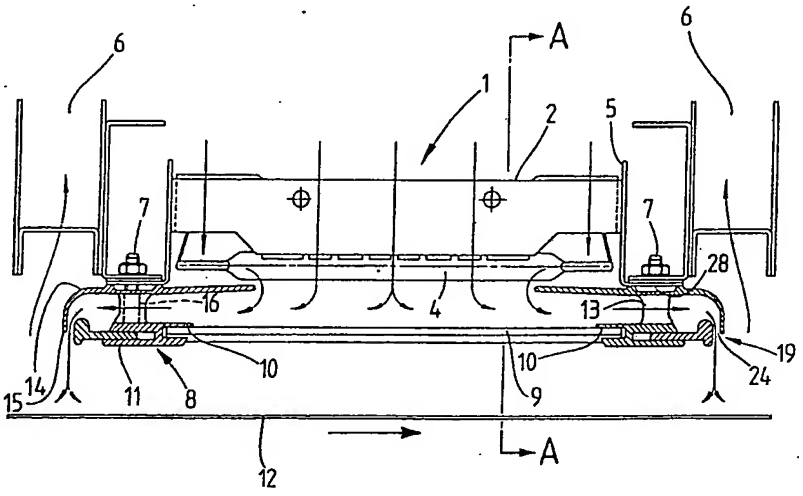

(57) Abstract

A method and a device (1) respectively designed to treat a paper web (12) by using heat radiation from infrared lamps (4) and cooling air, which flows around these lamps and against the paper web, glass plates (9) being used to shield the paper web from the infrared lamps and inserted in glass holders (8), in connection with which the cooling air is ejected against the paper web and is sucked off again. In order to improve the total efficiency, particularly as to an even and efficient drying of the paper web without using more but rather less energy the cooling air ejection holes adjacent the glass holders are designed as nozzles (19) directed against the paper web and having a steplessly adjustable gap width. The gap extends across all the width of the paper web and the cooling air is ejected from it with a high speed, forming a knife to tear apart the boundary layer of humid air which follows the paper web and subject the paper web to more intense heat treatment and a removal of additional parts of said boundary layer, when the paper web leaves the treatment area respectively.

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A method and a device of treating a continuous material web.

The present invention relates to a method of treating a continuous material web, particularly a paper web, according to the preamble to patent claim 1. Also, the invention relates to a device designed to carry out the method according to patent claim 1, which device is defined in more detail in the first device claim.

When e.g. paper materials are dried, a continuous paper web is run past one or several arrays of infrared heat elements. These elements comprise infrared lamps, mounted in reflector frameworks and separated from the paper web by means of glass plates in order to e.g. reduce the fire hazard and protect the lamps. Thus, the lamps must then be cooled and also the glass plates and the holders of the latter, because very high temperatures are reached. In order to obtain such a cooling, the area behind the reflector frameworks and their sheets as well as the glass holders is usually pressurized and the cooling air which is used is allowed through a system of cavities to flow past all the parts which are to be cooled and finally to leave the heat elements and flow against the paper web, from which the air is sucked and possibly reused in the drying process.

As to the above-mentioned conventional infrared heat elements the cooling air flows out usually through lines of holes or not aerodynamicly designed gaps across the web, which means that the cooling air is diffused very quickly close to the holes and reaches the paper web with a comparatively low speed. The speed usually is so low, that the boundary layer of humid air along the paper web surface and following it is not completely broken through. Consequently, the cooling air which flows against the paper web does not have a sufficient drying action, and thus several infrared heat elements are needed and/or an increased radiation intensity and amount of supplied energy. Also, when hole patterns are used, they may not cover the paper

web evenly in the perpendicular direction, a streak effect and consequently an uneven drying effect being obtained. Also, the holes and the gaps respectively cannot be adjusted and thus, the cooling air supply cannot be adjusted afterwards. The manufacturing and/or assembly costs can also be troublesome in conventional plants.

WO-A-87/005644 relates to an air-float drier, particularly for paper webs, a number of units including ventilation and infrared heat radiation devices being mounted on alternately opposite sides of a web which is to be dried. By means of the ventilation equipment air jets are directed substantially parallel to the web and the humid boundary layer of which consequently is not substantially influenced by the air jets, the main task of which is to bring about a pressurization in front of the infrared heat radiation equipment in order to bend the web away from said equipment and support or stretch it in this way. As is realized, the entire drying device is very bulky and expensive as regards its manufacturing, assembly and operation, its energy consumption being very large. One of the drawbacks of the device as to its drying effect is also that the ventilation air, which is supplied against the paper web, is not allowed to pass through the infrared heat radiation equipment to become heated there to an elevated and consequently drying-efficient temperature but is circulated around said equipment, whereas the air which passes through said equipment is removed through cavities 23 and 31 to be recirculated within the plant. The dimensions of the units are large and consequently the drying units of the entire assembly are very bulky, and how the ventilation air is taken care of is not discussed.

SE-B-404 213 relates to a device for drying a moving material web without a heat radiation equipment, the ventilation air being ejected against the material web through a screen of holes, which have different fimensions. It is

true that the air is ejected perpendicularly to the web surface, a continuous air-float effect being obtained, but the air stream unresiliently hits the boundary layer on the material web without being able to rip it open in any way. This drying device apparently is not very efficient and useful in applications, in which a maximum drying is to be accomplished within a minimum area, the supplied energy being utilized in a maximum way.

SE-B-455 709 relates to a combined infrared radiation and ventilation-drier, e.g. for paper webs. However, the ventilation air is not directed against the web at all but is run parallel to it, no boundary layer-influence at all taking place. Of course, the drier in this way has a strongly reduced efficiency and the energy consumption is large without being of any sufficient service.

The object of the present invention is to as regards what has been discussed above improve and further develop the conventional methods and devices for treating continuous material webs.

This object is achieved by carrying out a method of the type described in the introductory portion above in accordance with the characterizing clause of patent claim 1. Also, said object is achieved by means of a device according to the first device claim.

Additional characterizing features and advantages of the invention are set forth in the following description, reference being made to the accompanying drawings showing a preferred but not limiting embodiment and in which:
Fig. 1 shows a device according to the invention in a vertical sectional view;
Fig. 2 is a view along line A-A in Fig. 1;
Fig. 3 shows a detail according to Fig. 1 having a completely open damper;

Fig. 4 shows various views of a glass holder according to the invention; and
Fig. 5 is a view of one part of the glass holder shown in Fig. 4.

In the drawings a device 1 according to the invention is shown in its entirety. It comprises a reflector framework with reflector sheets 3 and infrared lamps 4. The frameworks are suspended in mounting means 5. In connection with the frameworks there preferably are exhaust air ducts 6 adjacent the two ends, through with ducts the predominant portion of the intake air, ejected towards the paper web, is removed, e.g. by means of negative pressure, not shown in detail. The intake air can be supplied by a fan, not shown, and flow through said frameworks in a way known per se and not shown in detail here.

Glass holders 8 are mounted below said mounting means 5, e.g. screwed on by means of screws 7 and in pairs support glass plates 9, which are inserted into grooves 10 in a lower holder part 11, which suitably is designed as a flat list, which extends in a plane parallel to and at a distance above a passing paper web 12. The two longitudinal sides of the list suitably are bevelled below and/or above the plane of the glass plates.

Glass holder part 11 suitably is made integral with e.g. two spacers 13, mounted at a distance from each other, and with a guide part 14 mounted above them, which latter is plate-shaped with an outer longer side, which is smoothly bent downwards towards the paper web and thus forms a guided flange 15. Different thicknesses of material can be used along the cross-section of the entire guided part, the flange e.g. being considerably thinner. Guide part 14 without its guide flange extends at least approximately in a plane-parallel direction in relation to holder part 11. A minor convergence can possibly be used towards the

flange at the inner half of guide part 14.

The fastening screws of the glass holders suitably extend through holes 16, which extend in a central direction through spacers 13 and the adjacent areas of parts 11 and 14.

There is also a groove 17 in the outwardly turned long edge of parts 11, which groove is designed to suitably displaceably in the longitudinal direction of the paper web receive a damper 18, which is a flat list 21 with the exception of the outer long edge, namely the edge facing flange 15, which suitably is thick and forms one side of a nozzle gap 19, the other side of which is formed by stationary flange 15. Said one side is a damper surface 20 having a plane which is parallell to flange 15 and suitably extends on the two sides of the plane, e.g. a center plane formed by said flat list 21. In connection with its plane-parallel extension surface 20 continues in a lower and an upper bend and the upper bend radius may be twice as large as the lower one. The bends are approximately half circular-cylindrical in such a way, that above list 21 a twice as wide and/or thick guide bead 22 is obtained as compared to a guide bead below list 21. Thanks to the described design of the damper an efficient cooling air flow is obtained at the inlet of the nozzle as well as at its outlet.

As is shown in the drawings the damper can be adjusted into various positions by inserting it into groove 17 to different depths and locked in these positions by means of screws 23 fastened in list 11. In this way a nozzle gap 24, formed by flange 15 and surface 20, is adjusted steplessly with a great accuracy. The free long edge of the flange can thus advantageously end approximately in front of the central part of surface 20 as regards its extension in a transversal direction in relation to the

paper web. Flange 15 is in its turn suitably positioned in front of the center of the corresponding exhaust air duct 6 as regards its extension in the longitudinal direction of the paper web. The gap width can be e.g. 4-11 mm and as large as 16 mm without the damper.

Flat list 21 is provided with holes 25, adjacent its ends and oblong in the displacement direction of the list and designed to surround screws 23. Between holes 25 there are recesses 26 in the flat list about spacers 13. Guide part 14 is on its free side provided with longitudinally through locating ribs 27, which have a trapezoidal profile, at either side of spacers 13 in order to hold and be positioned on raised portions 28, which extend downwards from the ends of each unit 1. Also, guide part 14 is provided with holes 29 and 30, designed to render possible and facilitate respectively an assembly and disassembly work.

Since, as is shown in the drawing, a series of devices according to the invention can be joined to each other in order to bridge the whole width of the paper web, the mutually adjacent device edges preferably being oblique, an uninterrupted gap is obtained and consequently a streakless treatment of the paper web as to heat treatment as well as to cooling air supply. Lastmentioned supply has never before been supposed to also result in a treatment but merely as a certain ejection zone for consumed cooling air. Thanks to the characterizing features of the present invention, also the feature that the cooling air can be strongly pressurized and consequently can have a high ejection speed through the nozzles, it is possible to transform the consumed cooling air, which in fact is a strongly heated exhaust air, to an air-knife, which extends across all the width of the paper web and with a speed of up to 70 m/sek. flows towards the paper web and efficiently penetrates the above-described boundary layer along the paper web and rips open this layer adjacent

the inlet to the first nozzle. In connection with this a forced drying-process can take place, since said boundary layer, which has been ripped open, now has a strongly reduced moisture content and absorbs less heat radiation as well as does not have a restraining effect on the moisture disappearance from the paper web any longer. The remaining parts of the boundary layer which has been ripped open are subsequently attacked on the downstream side of the second nozzle and also in this area takes place a more efficient vacuum removal of a major boundary layer portion in the exhaust air than what has been the case before, which also results in a forced drying downstreams of the IR-equipment.

The glass plates can form a closed unit across the width of the paper web, which does not allow exhaust air to flow through it, or a certain advantageous exhaust air discharge can take place, e.g. due to a mutual overlapping of the glass plates in a known way, which allows a small amount of air to flow through the overlapping zones. Such a limited outflow may contribute to the advantageous total efficiency of the device, i.a. due to an improved cleaning of said glass surfaces.

The characterizing features of the invention are:
The designed nozzle (the gap) can be adjusted in a simple fashion to the desired outflow speed in order to meet the requirements of different paper webs. A varying and adjustable outflow speed and a pressure impulse caused thereby against the paper web on the air supply side can in combination with a constant vacuum removal of exhaust air, integrated in the IR-housing, across the width of the web allow the IR-housing to function e.g. as a guide roller regarding the web having an arbitary bending direction. Thus, by adjusting the nozzles of the glass holders with different gap widths across the web different speeds/pressure impulses towards the web for different web sections

can be obtained, a positive actuation of the runnability of the paper web being attained, since the IR-housing then functions as a guide roller.

The nozzle is to be designed aerodynamicly in a proper way, in order to develop a satisfactory collected air stream, the maximum velocity of impact of the air against the paper web being insignificantly lower than the outlet-speed, also at a distance of 30-40 mm. If the outlet opening e.g. has sharp edges, turbulences and significant speed reductions are obtained.

The dimensions of the nozzle jointly with the overlapping of the glass plates can result in a pressurization under the plates with outlet speeds of up to 70 m/s and simultaneously a most efficient perpendicular impact blowing is used against the paper web in order to achieve a maximum convection heat transmission and boundary layer effect. The elevated outlet speed, almost twice as large as in conventional systems allows, jointly with the more collected air flow, a considerably improved drying effect, particularly pronounced in IR-positions with a high moisture content in the paper web.

The gap design of the glass holder allows, jointly with the position of the exhaust air duct, placed at a lower level, a maximum portion of the air supplied to the web to be captured and reused in other suitable drying sections in the process.

The adjustable gap width of the glass holders allows the impact flow speed against the paper web to be varied in a simple way in an IR-device to a suitable level for freely running paper webs having a low web tension. It is in this way possible to use the highest suitable supply air speed considering the runnability of each individual paper web and the need of influencing the boundary layer in connec-

tion with the drying.

The individual adjustable gap width and then also the impact blow speed, the pressure impulse of each module in the cross-direction of the web allows, jointly with an air exhausting device, mounted across the web and integrated in the IR-housing, i.e. the space above or behind the frameworks, an adjustment of a freely running web having a varying web tension/web handling in the transversal direction, which results in an improved runnability for the web and consequently a reduced web break frequency. A special case of this is the possibility described above to, by means of the guidable pressure impulses of the glass holders transversely to the web allow the IR-housing to function e.g. as a guide roller having a selectable bend direction regarding the web. In this connection it is important to take into consideration also the tension effect, which is obtained due to the suction zones 6 in connection with every blowing gap. A sufficiently large suction force, which is obtained through a corresponding negative pressure in suction ducts 6 will result in a certain web tension before and after each unit 1, positively counteracting and stabilizing the tensioning, which is obtained by means of said air-knives. Since it is easy and simple in a device according to the present invention to steplessly adjust the air supply and the exhaust air amounts as well as the gap width, in this way an excellent instrument is obtained designed to solve e.g. stabilization and break problems of a freely running material web, also in case such a web has a very low surface weight, e.g. about 30 g/m^2 and/or a high speed, e.g. about 1000 m/min.

CLAIMS

1. A method of treating a continuous material web (12), particularly a paper web, which by means of heat-ventilation-units (1) is flushed with air streams as well as heat-treated through radiation from infrared lamps (4), principally for drying, said infrared lamps being shielded from the material web by means of glass plates (9), inserted with its ends in glass holders (8), gap nozzles (19), mounted after each other in the direction of movement, designed for the ejection of said flush air streams, being formed from said glass holders and parts (14) placed outside the glass holders,
c h a r a c t e r i z e d in that said flush air is air used to cool the infrared lamps (4) and their surrounding equipment, which flush air in this way is transformed into a strongly heated exhaust air, which is pressurized and consequently will have a large ejection speed of preferably up to 70 m/sek. from the gap nozzles (19), in that a series of units (1) are attached to each other in order to bridge the entire width of the material web and in this way form uninterrupted gaps (24) och then also a streakless treatment of the material web as regards the heat treatment as well as the flush air supply by means of air-knives, formed in this way, extending transversely to the material web (12) in order to obtain a maximum convective heat transmission and a boundary layer influence and extended along all the width of the material web, the first air-knife as regards the direction of movement of the web being preceded by a vacuum zone (6), designed to preliminarily suck off air containing moisture and heat, and being used to tear apart said boundary layer, which follows the material web, in order to accomplish a subsequent forced drying process, and in that the remainders of the torn apart boundary layer downstreams are attacked by the second air-knife and sucked off through a subsequent vacuum zone (6).

2. A device designed to carry out the method according to claim 1, in which a continuous material web (12), particularly a paper web, by means of heat-ventilation-units (1) will be flushed with air streams as well as heat-treated through a radiation by means of infrared lamps (4), particularly in order to dry the material web, the infrared lamps being shielded from the material web by means of glass plates (9), inserted with their ends in glass holders (8), gap nozzles (19) designed for the ejection of said flush air streams, mounted after each other and formed in the direction of movement of the web by said glass holders and parts (14) positioned outside the glass holders, c h a r a c t e r i z e d in that the used flush air is air for cooling the infrared lamps (4) and their surrounding equipment, in that the flush air in this way will be transformed into a strongly heated exhaust air, which will be pressurized and consequently will have a large ejection speed of preferably up to 70 m/sek. from the gap nozzles (19), in that a series of units (1) are attached to each other in order to bridge the entire width of the material web and to form uninterrupted gaps (24) and consequently achieve a streakless treatment of the material web as regards heat radiation as well as flush air supply by means of air-knives, formed in this way and extending along the entire width of the material web (12) and extending transversely to the material web in order to obtain a maximum convective heat transmission and a boundary layer influence, the first air-knife as regards the direction of movement of the web being preceded by a vacuum duct (6), designed for a first suction-off of air containing moisture and heat, and being used to tear apart said boundary layer, which follows the material web, in order to accomplish a subsequent forced drying-process, and in that the remainders of the torn apart boundary layer downstreams are attacked by the second air-knife and sucked off through a subsequent vacuum duct (6).

3. A device according to claim 2, c h a r a c t e r i z e d in that each unit (1) comprises a reflector framework (2) with reflector sheets (3) and said infrared lamps (4) and with suspension means (5), in which the frameworks are mounted and in connection with these elements preferably exhaust air ducts (6) are provided at the two ends, through which ducts the major part of the supplied air, ejected against the paper web (12), is removed, e.g. by means of a negative pressure, not explained in detail, whereas the supplied air will be fed from a fan and flow through the frameworks in a way known per se.

4. A device according to claim 3, c h a r a c t e r i z e d in that below the suspension means (5) said glass holders (8) are mounted, e.g. fastened by means of screws (7), which glass holders in pairs between them support said glass plates (9), which are inserted in grooves (10) in a lower holder part (11), which suitably is a flat list, extending in a plane parallel to and at a distance above the passing paper web (12), and in that the two long sides of the list suitably are bevelled below and/or above the plane of the glass plates.

5. A device according to claim 4, c h a r a c t e r i z e d in that the glass holder part suitably is made integral with e.g. two spacers (13), mounted at a distance from each other, and above said spacers a guide part (14), which is a plate having an outer long side, which is slightly bent downwards towards the paper web and forms a guide flange (15), different thicknesses of material preferably being provided along the entire cross-section of the guide part, the flange e.g. being considerably thinner, and in that the guide part (14) without the guide flange extends at least approximately in a plane parallel to the holder part (11), preferably a slight convergence towards the flange at the inner half of the guide part (14) being provided.

6. A device according to claim 5, c h a r a c t e r i z e d in that the fastening screws (23) of the glass holders (8) are inserted through holes (16), which extend centrally through said spacers (13) and the adjacent areas of the lower glass holder part (11) and the guide part (14).

7. A device according to claim 5, c h a r a c t e - r i z e d in that in the outwardly turned long edge of the lower glass holder part (11) there is a groove (17), which is designed to receive, suitably displacebly, in the longitudinal direction of the paper web a damper (18), which is a flat list (21) with the exception of the outer long edge, i.e. the long edge which faces the flange (15), which long edge suitably through a widening forms one side of a gap nozzle (19), the other side of which is formed by the stationary flange (15).

8. A device according to claim 7, c h a r a c t e - r i z e d in that said one side of the damper (18) is a damper surface (20), the plane through which is parallel to said flange (15) and which suitably extends on both sides of that plane, e.g. a central plane, which is formed of said flat list (21), in that said surface (20) adjacent the plane-parallel extension continues in a lower and an upper bead, the upper bending radius suitably being twice as large as the lower one, and in that the beads are approximately half circular-cylindrical, a guide bead (22) being obtained above the flat list (21), which is twice as wide and/or thick as the guide bead obtained below the list (21).

9. A device according to claim 8, c h a r a c t e - r i z e d in that the damper (18) is adjustable into different positions by inserting it to different depths into the groove (17) and is locked in the different positions by means of the screws (23) fastened in the lower holder part (11), a steplessly adjustable nozzle gap (24)

being formed by the flange (15) and the surface (20), the free long edge of the flange preferably ending roughly opposite to the central part of the surface (20) as regards its extenison transversely to the paper web (12), and in that the width of the gap can be adjusted to e.g. between 4 and 11 mm and can be adjusted to 16 mm without said damper respectively.

10. A device according to claim 9, c h a r a c t e r i z e d in that the flange (15) suitably is positioned opposite the central area of the corresponding exhaust air duct (6) as regards its extension in the longitudinal direction of the paper web.

FIG. 2

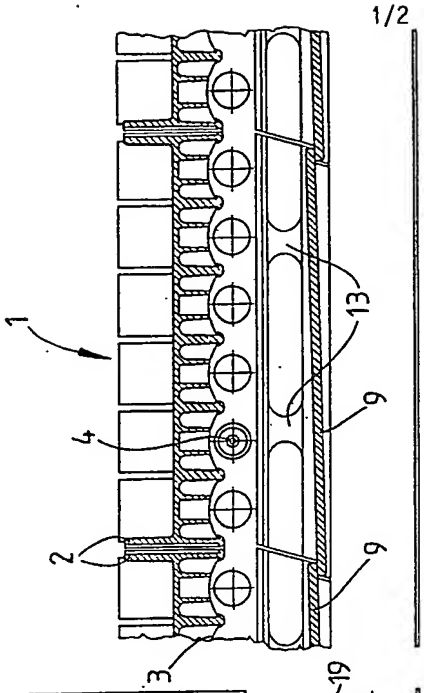

FIG. 1

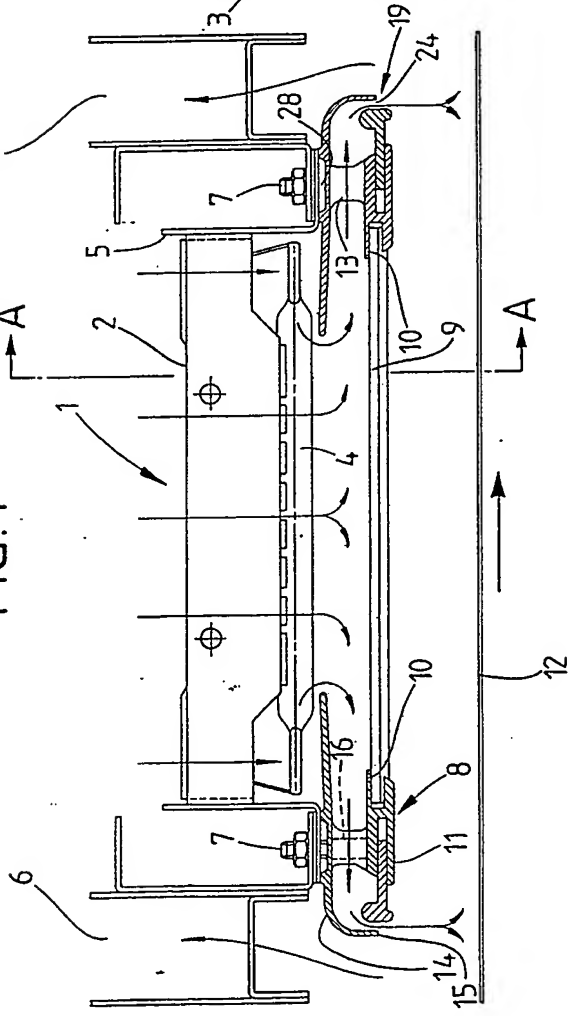

FIG. 3

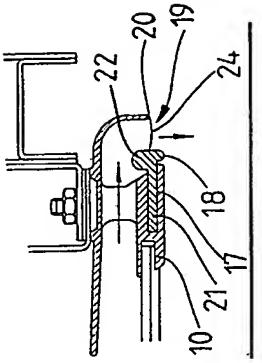

FIG.4

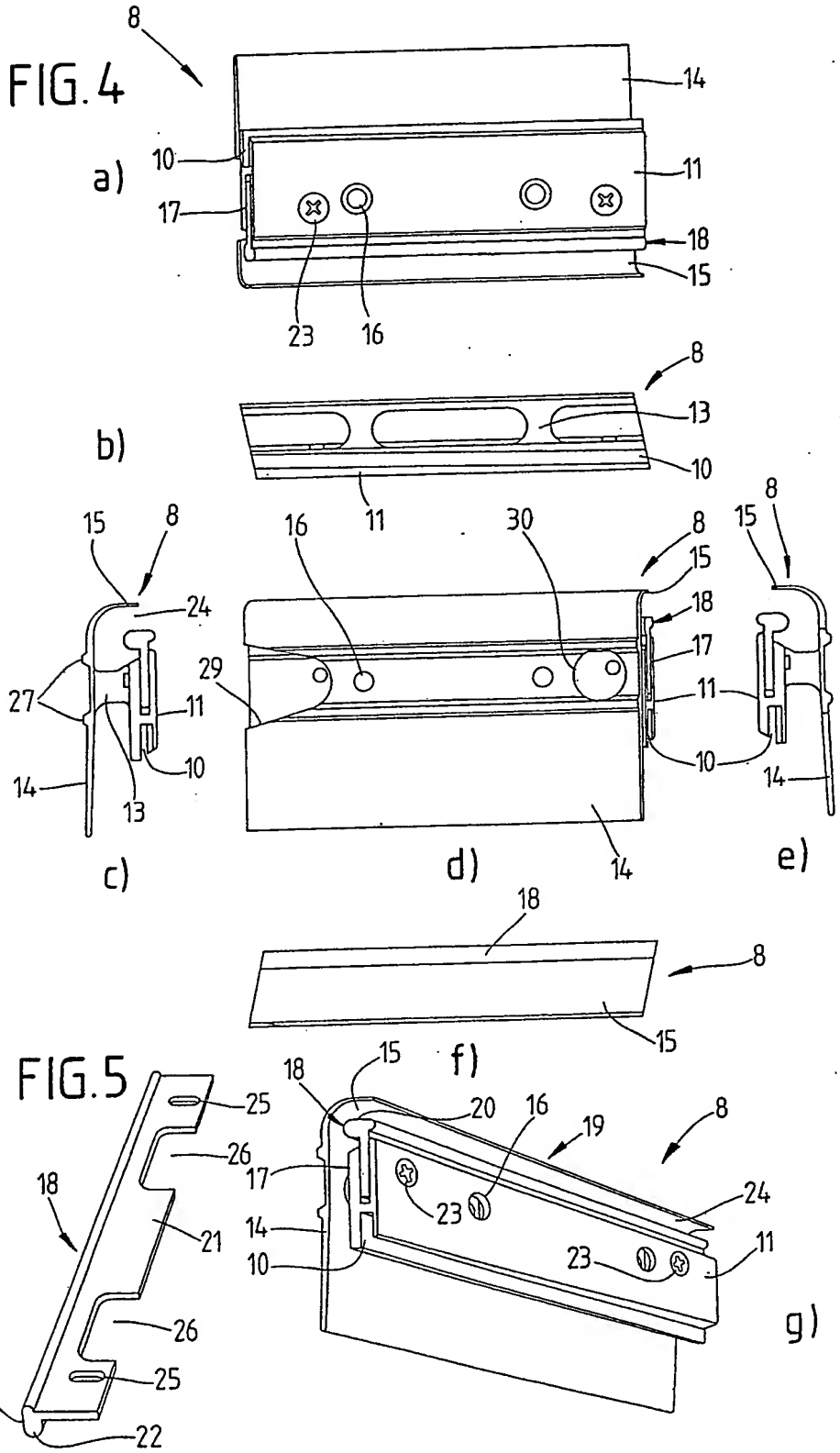
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FIG.5

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INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00256

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: D 21 F 5/00, F 26 B 3/30

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	D 21 F; F 26 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	SE, B, 455709 (ITRONIC PROCESS AB) 1 August 1988, see the whole document --	
A	WO, A1, 8705644 (VALMET PAPER MACHINERY INC.) 24 September 1987, see the whole document --	
A	SE, B, 454707 (KIMBERLEY-CLARK LTD) 24 May 1988, see page 9, line 5 - line 7 --	1,2

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30th July 1991	1992 -08- 03
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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		EP-A-B-	0263136	88-04-13
		JP-T-	63502730	88-10-13
		US-A-	4854052	89-08-08
SE-B- 454707	88-05-24	AU-B-	550605	86-03-27
		AU-D-	8282882	82-11-04
		BE-A-	892957	82-08-16
		CA-A-	1185787	85-04-23
		DE-A-	3215515	82-11-18
		FR-A-	2504567	82-10-29
		GB-A-B-	2099970	82-12-15
		JP-A-	57183494	82-11-11
		NL-A-	8201672	82-11-16
		US-A-	4462868	84-07-31